(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 926 361 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
30.06.1999 Bulletin 1999/26

(51) Int Cl.[6]: F16B 19/14, B21H 1/18, B21H 7/14

(21) Application number: 98403215.1

(22) Date of filing: 18.12.1998

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 19.12.1997 US 994521

(71) Applicant: ILLINOIS TOOL WORKS INC.
Glenview, Cook County, Illinois 60025 (US)

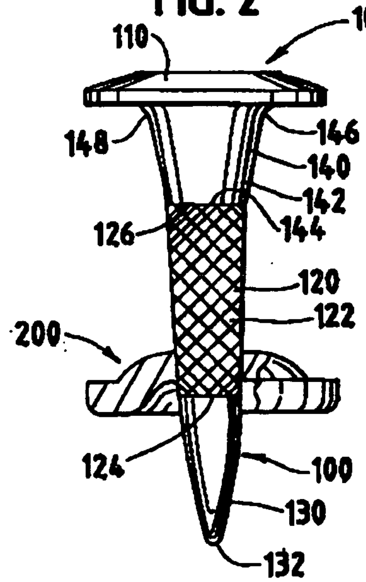
(72) Inventors:
- Olvera, Gilbert
  Chicago, Illinois 60640 (US)
- Velan, George M.
  Mt. Prospect, Illinois 60056 (US)

(74) Representative: Bloch, Gérard
2, square de l'Avenue du Bois
75116 Paris (FR)

(54) Pin, pin and washer fastener, washer for the fastener and pin-making method

(57) The pin, for penetration into a steel, concrete, or masonry substrate, has a head (110), a tapered shank (120), a point (130) and a transition zone (140) between the tapered shank and the head. The point (130) is joined unitarily to the smaller end (124) of the tapered shank (120). The transition zone (140) has a tapered portion with a smaller end (144) joined unitarily to the larger end (126) of the tapered shank and a with larger end (146) joined unitarily to the head (110).

FIG. 2



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Printed by Jouve, 75001 PARIS (FR)

Description

[0001] This invention pertains to a pin for axial, non-rotational penetration into a steel, concrete, or masonry substrate, to a fastener comprising such a pin and a washer, and to a washer useful with the pin in the fastener. This invention also pertains to a method of making such a pin.

[0002] As exemplified in U.S. Patent N° 4,824,003, it is known to provide a pin having a head, a shank, and a point with a washer having an outer diameter equal approximatively to the outer diameter of the head, for guiding the pin in the muzzle, barrel, or nosepiece of a driving or setting tool. The washer is carried on the shank, in axially spaced relation to the head, and is movable toward the head when the pin with the washer is driven forcibly into a substrate, either directly or through a workpiece, so that the washer bears against the substrate or the workpiece. As exemplified therein, the washer also performs an energy-absorbing function.

[0003] As exemplified by a pin made and sold by Societe de Prospection et d'Inventions Techniques SPIT, of France, under Product Designation SBR 14, it is known for the pin to have a head, an ogival point, a knurled shank, which is not tapered, and a transition zone having a tapered portion between the knurled shank and the head. The SBR 14 pin is made from carbon steel having a carbon content in a range from 0.58 percent to 0.62 percent.

[0004] As known heretofore, the steel pin can be made from a predetermined length of carbon steel wire, which has a carbon content not less than 0.35 percent and which can be surface hardened or through hardened. AISI C 1038 steel, which has a carbon content in a range from 0.35 percent to 0.41 percent, can be thus used. Moreover, the predetermined length of carbon steel wire is formed in an initial step so as to form an intermediate part, which has a head to become the head of the steel pin, a shank to become the shank of the steel pin, and an end portion, on which the point is formed in a further step. As known heretofore, the point is formed by rotary swaging or by so-called "pinch pointing", which refers to forging between two forging dies.

[0005] The instant invention provides improvements in a pin for axial, non-rotational penetration into a steel, concrete, or masonry substrate, in a washer useful with the pin, in a fastener comprising the pin and the washer, and in a method of making the pin. The fastener is designed to be forcibly driven so that the pin is driven into a steel, concrete, or masonry substrate, either directly or through a workpiece.

[0006] Broadly, the pin is made from a predetermined length of wire with an initial diameter and comprises a head, a tapered shank, a point, and a transition zone.

[0007] The head of the pin has an outer diameter at least about 2.6 times greater than the initial diameter of the predetermined length of wire. Thus, the pin differs materially from the prior pin sold under Product Designation SBR 14, in which the head had an outer diameter about 2.3 times the initial diameter of the predetermined length of wire used to make the prior pin sold thereunder. Heretofore, it was thought that the maximum diameter of the head of a pin was about 2.3 times the initial diameter, because the pins would be inconsistent due to non-round heads or to cracks caused by over work-hardening.

[0008] The tapered shank of the pin defines a comparatively smaller conical angle and has a smaller end and a larger end. Its smaller end has a diameter smaller than the initial diameter of the predetermined length of wire, preferably being about 0.6 times the initial diameter thereof. Preferably, the larger end of the tapered shank has a diameter about 0.7 times the initial diameter of the predetermined length of wire. The tapered shank pin is especially useful in attaching to a bar joist because it develops sufficient holding power by continuously sizing the hole that it forms in the bar joist.

[0009] Being joined unitarily to the smaller end of the tapered shank, the point conforms substantially to an ogive, preferably to tangent ogive, which is tangent to the tapered shank. Although the point conforms substantially to an ogive, the point may have a rounded tip.

[0010] The transition zone has a tapered portion defining a comparatively larger conical angle between the tapered shank and the head. The tapered portion of the transition zone has a smaller end joined unitarily to the larger end of the tapered shank. The tapered portion thereof has a larger end joined unitarily to the head.

[0011] Preferably, the larger end of the tapered portion of the transition zone has a diameter about 1.1 times the initial diameter of the predetermined length of wire. Preferably, the tapered shank defines a conical angle (total taper) in a range from about 2° to about 4°, and the axial length of the transition zone is less than about one half of the axial length of the tapered shank.

[0012] As improved by this invention, the washer is annular and has an annular periphery and a central aperture, which has a margin with a novel configuration. The margin of the central aperture defines plural projections with pin-engaging surfaces spaced angularly from one another. Each pinengaging surface conforms essentially to a cylindrical section. Collectively, the pin-engaging surfaces encompass a minor portion of a complete cylinder, not less than about one third of a complete cylinder.

[0013] Preferably, the margin of the central aperture of the washer defines exactly four of the pin-engaging surfaces, which are spaced regularly from one another. Preferably, moreover, each pin-engaging surface is configured so as to encompass about one twelfth of a complete cylinder.

[0014] The washer improved by this invention can be advantageously combined with a pin, such as the pin improved by this invention, to provide an improved fastener. In the improved fastener, the annular periphery of the washer has an outer diameter equal approximately

to the outer diameter of the head and wherein the central aperture of the washer enables the washer to be tightly fitted over the tapered shank, near the smaller end of the tapered shank, when the pin and washer assembly is assembled. Thus, when the fastener is driven forcibly so that the pin is driven into a steel, concrete, or masonry substrate, the washer and the head are arranged to guide the fastener through the muzzle, barrel, or nosepiece of the driving or setting tool and the washer is arranged to be forcibly moved along the tapered shank, toward the larger end of the tapered shank, as the pin enters the substrate.

[0015] As improved by this invention, the method of making a pin for axial, non-rotational penetration of a steel, concrete, or masonry substrate, such as the pin improved by this invention, contemplates making the pin from a predetermined length of carbon steel wire with an initial diameter and with a carbon content in a range from about the carbon content of AISI C 1038 steel to about the carbon content of AISI C 1065 steel, preferably from a predetermined length of AISI C 1062 steel wire, by successive forming, rolling, and heat treating steps.

[0016] In the forming step, which may be also called a heading step, the predetermined length of carbon steel wire is formed so as to form an intermediate part, which is elongate and which has a head on one end and a shank between its ends. If the shank is tapered, it is generally tapered in the forming step. In the rolling step, the intermediate part is rolled so as to form a point conforming substantially to a tangent ogive, which is tangent to the shank, whereby a pin is formed. If the shank is knurled, it is knurled in the rolling step. In the heat treating step, the pin is hardened, preferably by austempering so as to provide the pin with a surface hardness of not greater than Rockwell C 52, preferably not greater than Rockwell C 48. The core hardness is preferably between Rockwell C 48 and Rockwell C 58. Optionally, the pin is decarburized in a conventional manner, after the rolling step, before the heat treating step.

[0017] These and other objects, features, and advantages of this invention are evident from the following description of a preferred mode for carrying out this invention, with reference to the accompanying drawings, in which

Figure 1 is a fragmentary perspective view of a fastener comprising a pin and a washer ans constituting a preferred embodiment of this invention, as used to fasten a steel decking member to a steel bar joist ;

Figure 2, on an enlarged scale, is an elevational view of the pin and a cross-sectional view of the washer, after the pin and the washer have been combined to provide the fastener and before the fastener has been driven ;

Figure 3, on a similar scale, is an elevational view of an intermediate part, after a predetermined length of wire has been formed to form the intermediate part and before the intermediate part has been rolled to form the pin ;

Figure 4, on a similar scale, is a plan view of the washer, as seen from above;

Figure 5, on a similar scale, is a sectional view of the washer, as taken along line 5-5 of Figure 4, in a direction indicated by arrows ;

Figure 6 is a further enlarged, fragmentary detail, as taken from Figure 4 ;

Figures 7, 8, and 9 are schematic views of initial, intermediate, and final stages in a rolling process, as seen from below, in which the intermediate part is rolled between two rolling dies to form the pin and Figures 10, 11, and 12 are schematic views of the same stages of the rolling process, as seen from one end of the rolling dies.

[0018] As shown in Figure 1, an improved fastener 10 comprising a steel pin 100 in an improved form to be later described and a steel washer 200 in an improved form to be later described and constituting a preferred embodiment of this invention is useful for fastening a steel decking member 12, which is made from thin sheet steel oftentimes, to a steel bar joist 14.

Here, the decking member 12 is regarded as a workpiece, and the bar joist 14 is regarded as a substrate. The fastener 10 is shown in Figure 2, as assembled from the pin 100 and the washer 200, before the fastener 10 is driven.

[0019] In a preferred application of this invention, the fastener 10 can be forcibly driven by a fastener-driving tool, such as a powder-actuated tool, as exemplified by the powder-actuated, nosepiece-equipped, fastener-driving tool disclosed in U.S. Patents No. 5,193,729, No. 5,199,506, and No. 5,199,625, the disclosures of which are incorporated herein by reference. If such a tool is used, the fastener 10 is sized to be axially guided in its nosepiece, in a manner to be later described.

[0020] In an alternative application of this invention, the fastener 10 can be forcibly driven by a powder-actuated, fastener-driving tool, as exemplified by the powder-actuated, muzzle-equipped, fastener-driving tool disclosed in U.S. Patent No. 4,824,003, the disclosure of which is incorporated herein by reference. If such a tool is used, the fastener 10 is sized to enable the fastener 10 to be muzzle-loaded, in a manner disclosed therein.

[0021] Broadly, the steel pin 100 comprises a head 110, a shank 120, a point 130, and a transition zone 140 between the shank 120 and the head 110. The washer 200 is carried on the shank 120, in axially spaced relation to the head 110, and is movable toward the head 110 when the fastener 10 is driven forcibly through the decking member 12, into the bar joist 14, so that the washer 200 bears against the decking member 12.

[0022] The tapered shank 120 of the steel pin 100 defines a conical angle (total taper), preferably in a range

from about 2° to about 4°, and has a knurled surface 122, a smaller end 124, and a larger end 126. The smaller end 124 has a diameter smaller than the initial diameter of the predetermined length of carbon steel wire, preferably being about 0.6 times the initial diameter thereof. The larger end 126 has a diameter about 0.7 times the initial diameter of the predetermined length of carbon steel wire.

[0023] Being joined unitarily to the smaller end 124 of the tapered shank 120, the point 130 has a tip 132 and conforms except at the tip 132, which is rounded, substantially to a tangent ogive, which is tangent to the tapered shank 120.

[0024] Being between the tapered shank 120 and the head 110, the transition zone 140 has a tapered portion 142 defining a comparatively larger conical angle, preferably a conical angle (total taper) of about 40°. The tapered portion 142 has a smaller end 144 joined unitarily to the larger end 126 of the tapered shank 120. The tapered portion 142 has a larger end 146 joined unitarily to the head 110, via a circumferential fillet 148, which is regarded as an integral part of the transition zone 140.

[0025] The larger end 146 of the tapered portion of the transition zone has a diameter larger than the initial diameter of the predetermined length of carbon steel wire, preferably about 1.1 times the initial diameter thereof. The axial predetermined length of the transition zone 140, which includes the circumferential fillet 148, is less than about one half of the axial length of the tapered shank 120. It is convenient next to describe the material used to make the steel pin 100.

[0026] The steel pin 100 is made from a predetermined length of carbon steel wire, which has a carbon content in a range from about the carbon content of AISI C 1038 steel, which has a carbon content from 0.35 percent to 0.38 percent, to about the carbon content of AISI C 1065 steel, which has a carbon content from 0.60 percent to 0.70 percent. A high-manganese carbon steel having a carbon content in a similar range, such as AISI C 1062 high-manganese carbon steel, can be alternatively used. In a preferred mode for carrying out this invention, a predetermined length of AISI C 1062 steel wire is used, which has an initial diameter of about 0.208 inch.

[0027] In an alternative embodiment, such as a pin for fastening to thinner steel, a lower core hardness for the pin may be used, so that a lower carbon wire may be used to create the pin. Also, a more aggressive knurl may be preferred in this application, possibly a knurl with a slight helix.

[0028] In a preferred mode for carrying out this invention, the steel pin 100 has novel proportions, which may be conveniently referenced to the initial diameter of the predetermined length of carbon steel wire used to make the pin 100. The head 110 has an outer diameter at least about 2.6 times greater than the initial diameter of the predetermined length of carbon steel wire. The tapered shank 120 has a larger end 126, which has a diameter about 0.7 times the initial diameter of the predetermined length of carbon steel wire, and the larger end of the tapered portion of the transition zone has a diameter about 1.1 times the initial diameter of the predetermined length of carbon steel wire.

[0029] In an initial step, which is a forming step that may be also called a heading step and which is performed with conventional head-forming equipment for forming heads on pins or screws, the predetermined length of carbon steel wire is formed so as to form an intermediate part 150, which is elongate and has a headed end 152 and an opposite end 154. Suitable head-forming equipment is available commercially from National Machinery Company of Tiffin, Ohio, under Model 56.

[0030] As shown in Figure 3, the intermediate part 150 has the head 110, which is formed on the headed end 152, the shank 120, which is tapered but not yet knurled, the transition zone 140, which is disposed between the head 110 and the shank 120, and the opposite end 154. In a further step to be next described, the point 130 is formed on the opposite end 154, and the tapered shank 120 may be knurled. It is preferred for the tapered shank 120 to be knurled.

[0031] In the further step, which is a rolling step performed with conventional form-rolling equipment for rolling threads on screws, the intermediate part 150 is rolled between two rolling dies D_1, D_2, which employ the head 110 as a datum and which are configured suitably. Suitable form-rolling equipment is available commercially from E. W. Menn GmbH Maschinenfabrik of Hilgenbach, Germany, under Model GW 120-H.

[0032] As the rolling dies undergo relative movement from an initial stage shown schematically in Figures 7 and 10, through an intermediate stage shown schematically in Figures 8 and 11, to a final stage shown schematically in Figures 9 and 12, the intermediate part 150 is rolled so as to form the point 130 and so as to knurl the tapered shank 120, if the tapered shank 120 is to be knurled, whereby the pin 100 is formed. As formed in the rolling step, the point 130 has a tip 132 and conforms except at the tip 132, which is rounded, substantially to a tangent ogive, which is tangent to the tapered, knurled shank 120. A fragment 156 of the pointed end 154 is removed at the end of the die travel. It has been found that relatively long dies are preferable so that the movement of material in the pin is slow and the point of the pin is not overheated, and thus over work-hardened, whereby a uniform, smooth surface results, without laps or seams.

[0033] In a final step, which is an austempering step performed with conventional heat treating equipment, the pin 100 is austempered so as to have a surface hardness not greater than about Rockwell C 48, or not greater than about Rockwell C 52 if the tapered shank 120 is not knurled, and a core hardness in a range from about Rockwell C 48 to about Rockwell C 58. Suitable heat treating equipment is available commercially from nu-

merous sources. Optionally, the pin 100 is decarburized in a conventional manner, after the rolling step, before the austempering step.

[0034] The steel washer 200 is stamped from a sheet of carbon steel, such as AISI C 1038 steel, which is preferred. Being annular, the washer 200 has an annular periphery 202 and a central aperture 210, which has a margin 212 with a novel configuration. The washer 200 is solid between the annular periphery 202 and the margin 212 of the central aperture 210. The margin 212 of the central aperture 210 defines four pin-engaging protrusions 214, which have concave pin-engaging surfaces 216, which are similar to one another, and which are spaced angularly and regularly from one another by four similar recesses 218. Before the washer 200 is fitted onto the pin 100, each pin-engaging surface 216 conforms essentially to a section of an imaginary cylinder of a given diameter. Each recess 218 conforms essentially to a section of an imaginary cylinder of a larger diameter.

[0035] Collectively, as contemplated by this invention, the pin-engaging surfaces 216 encompass a minor portion of a complete cylinder. As shown, in the preferred mode for carrying out this invention, each pin-engaging surface 216 encompasses about 30°, which is one twelfth of a complete cylinder. Collectively, in the preferred mode for carrying out this invention, the pin-engaging surfaces 216 encompass about one third of a complete cylinder.

[0036] In the improved fastener 10, the annular periphery 202 of the washer 200 has an outer diameter equal approximately to the outer diameter of the head 110 of the pin 100. Further, the central aperture 210 of the washer 200 enables the washer 200 to be tightly fitted over the tapered shank 120 of the pin 100, near the smaller end 124 of the tapered shank 120, when the fastener 10 is assembled. Thus, there is sufficient contact area that when the fastener 10 is driven by a powder-actuated tool or an equivalent tool and is accelerated, the washer 200 does not move significantly along the tapered shank 120 but stays near the point 130. Being spaced axially, the washer 200 and the head 100 of the pin guide the fastener 10 without permitting the fastener 10 to tumble in the nosepiece of a nosepiece-equipped, fastener-driving tool, as discussed above.

[0037] Also, when the fastener 10 is driven, the washer 200 is arranged to be forcibly moved along the tapered shank 120, toward the larger end 126 of the tapered shank 120, when the washer 200 engages a workpiece or a substrate. Because the pin-engaging surfaces 214 of the washer 200 encompass about one third of a complete cylinder, the pin-engaging surfaces 214 limit potential damage to the knurled surface 122 of the tapered shank 120 of the pin 100 when the washer 200 is moved along the tapered shank 120, toward the larger end 126 of the tapered shank 120.

[0038] Various modifications may be made in the preferred mode for carrying out this invention without departing from the scope and spirit of this invention.

Claims

1. For axial, non-rotational penetration into a steel, concrete, or masonry substrate, a pin formed from a predetermined length of wire with an initial diameter, comprising

   (a) a head (110) having an outer diameter at least about 2.6 times greater than the initial diameter of the predetermined length of wire,

   (b) a tapered shank (120) defining a conical angle and having a smaller end (124) and a larger end (126), the smaller end (124) of the tapered shank (120) having a diameter smaller than the initial diameter of the predetermined length of wire,

   (c) a point (130) joined unitarily to the smaller end (124) of the tapered shank (120) and conforming substantially to an ogive, and

   (d) a transition zone (140) having a tapered portion defining a conical angle between the tapered shank (120) and the head (110), the transition zone (140) having a smaller end (144) joined unitarily to the larger end (126) of the tapered shank (120) and a larger end (146) joined unitarily to the head (110),

   wherein the conical angle defined by the tapered portion of the transition zone (140) is larger than the conical angle defined by the tapered shank (120).

2. The pin of claim 1 wherein the point (130) conforms substantially to a tangent ogive, which is tangent to the tapered shank (120).

3. The pin of claim 1 wherein the smaller end (124) of the tapered shank (120) has a diameter about 0.6 times the initial diameter of the wire.

4. The pin of claim 3 wherein the larger end (146) of the tapered portion of the transition zone (140) has a diameter greater than the initial diameter of the predetermined length of wire.

5. The pin of claim 4 wherein the larger end (126) of the tapered shank (120) has a diameter about 0.7 times the initial diameter of the predetermined length of wire and wherein the larger end (146) of the tapered portion of the transition zone (140) has a diameter about 1.1 times the initial diameter of the predetermined length of wire.

6. The pin of claim 5 wherein the tapered shank (120) defines a conical angle in a range from about 2° to about 4° and wherein the transition zone (140) has

an axial length, which is less than about one half of the axial length of the tapered shank (120).

7. The pin of any one of claims 1 through 6 wherein the tapered shank (120) is knurled (122).

8. The pin of claim 7 wherein the point (130) has a rounded tip (132).

9. The pin of any one of claims 1 through 8, wherein the pin (100) is formed from a carbon steel wire with a carbon content in a range from about the carbon content of AISI C 1038 steel to about the carbon content of AISI C 1065 steel, the pin having a surface hardness not greater than about Rockwell C 52 and a core hardness in a range from about Rockwell C 48 to about Rockwell C 58.

10. The pin of claim 9, as formed from a predetermined length of AISI C 1062 steel wire, with a surface hardness not greater than about Rockwell C 48.

11. The pin of any one of claims 9 or 10, as formed from a length of high-manganese carbon steel wire.

12. A washer useful with a pin according to claim 1, the washer being annular and having an annular periphery (202) and a central aperture (210) the central aperture having a margin defining plural, concave, pin-engaging surfaces (216) spaced angularly from one another, the washer being solid between the annular periphery (202) and the margin (212) of the central aperture, each pin-engaging surface (216) conforming essentially to a cylindrical section, which pin-engaging surfaces (216) collectively encompass a minor portion of a complete cylinder, not less than about one third of a complete cylinder.

13. The washer of claim 12 wherein the margin (212) of the central aperture of the washer defines exactly four of the pin-engaging surfaces (216), which are spaced regularly from one another.

14. The washer of claim 13 wherein each pin-engaging surface (216) is configured so as to encompass about one twelfth of a complete cylinder.

15. A fastener comprising the washer of any one of claims 12 to 14 and the pin of claim 1,

wherein the annular periphery (202) of the washer (200) has an outer diameter equal approximately to the outer diameter of the head (110) of the pin, wherein the central aperture (210) of the washer enables the washer to be tightly fitted over the tapered shank (120) of the pin, near the smaller end (124) of the tapered shank (120), when the pin and washer assembly is assembled,

wherein the washer (200) and the head (110) of the pin are arranged to guide the fastener and the washer is arranged to be forcibly moved along the tapered shank (120), toward the larger end (126) of the tapered shank (120), when the pin is driven forcibly into such a substrate.

16. A method of making a steel pin according to claim 1, for axial, non-rotational penetration of a steel, concrete, or masonry substrate, from a predetermined length of carbon steel wire with an initial diameter and with a carbon content in a range from about the carbone content of AISI C 1038 steel to about the carbon content of AISI C 1065 steel, the method comprising the steps of

(a) forming the predetermined length of carbon steel wire so as to form an intermediate part (150), which is elongate and which has two ends (152, 154), a head (110) on one end (152) of the intermediate part, and a shank (120) between the ends of the intermediate part,

(b) rolling the intermediate part (150) so as to form a point (130) conforming substantially to an ogive, whereby a pin (100) is formed, and

(c) heat treating the pin so as to harden the pin.

17. The method of claim 16 wherein the intermediate part (150) is rolled so as to form the point (130) conforming substantially to a tangent ogive, which is tangent to the shank (120).

18. The method of claim 16 wherein the heat treating step comprises austempering the pin so as to provide the pin with a surface hardness not greater than about Rockwell C 48.

19. The method of claim 16 wherein the heat treating step comprises austempering the pin so as to provide the pin with a core hardness in a range from about Rockwell C 48 to about Rockwell C 58.

20. The method of claim 19 wherein the heat treating step comprises austempering the pin so as to provide the pin with a surface hardness not greater than about Rockwell C 48.

21. The method of claim 20 wherein the predetermined length of carbon steel wire is formed in the forming step so that the head (110) has an outer diameter at least about 2.6 times greater than the initial diameter of the predetermined length of carbon steel wire.

22. The method of claim 21 wherein the predetermined length of steel wire is formed in the forming step so that the shank (120) is tapered between a larger end (126), which is nearer to the head (110), and a smaller end (124), at which the point (130) is formed.

23. The method of claim 22 wherein the predetermined length of carbon steel wire is formed in the forming step so that smaller end (124) of the tapered shank (120) has a diameter about 0.6 times the initial diameter of the carbon steel wire.

24. The method of claim 23 wherein the predetermined length of carbon steel wire is formed in the forming step so that the intermediate part has a transition zone (140) having a tapered portion with a smaller end (144), which is joined unitarily with the larger end (126) of the tapered shank (120), and with a larger end (146), which is joined unitarily to the head (110).

25. The method of claim 24 wherein the predetermined length of carbon steel wire is formed in the forming step so that the larger end (146) of the tapered portion of the transition zone (140) has a diameter greater than the initial diameter of the predetermined length of carbon steel wire.

26. The method of claim 25 wherein the predetermined length of carbon steel wire is formed in the forming step so that the larger end (126) of the tapered shank (120) has a diameter about 0.7 times the initial diameter of the predetermined length of carbon steel wire and wherein the larger end (146) of the tapered portion of the transition zone (140) has a diameter about 1.1 times the initial diameter of the predetermined length of carbon steel wire.

27. The method of any one of claims 16 through 26 wherein the predetermined length of carbon steel wire is rolled in the rolling step so that the shank (120) is knurled (122) between the larger and smaller ends of the shank.

28. The methof of any one of claims 15 through 26 wherein the pin is formed from a predetermined length of AISI C 1062 steel wire.

29. The methof of claim 28 wherein the predetermined length of AISI C 1062 steel wire is rolled in the rolling step so that the shank (120) is knurled (122) between the larger and smaller ends of the shank.

30. The method of any one of claims 15 through 26 wherein the pin is formed from a predetermined length of high-manganese carbon steel wire.

FIG. 1

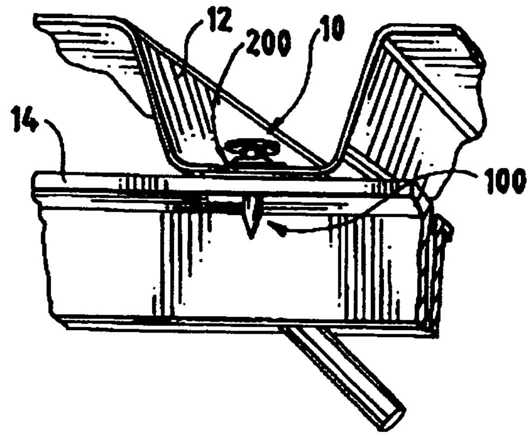


FIG. 2

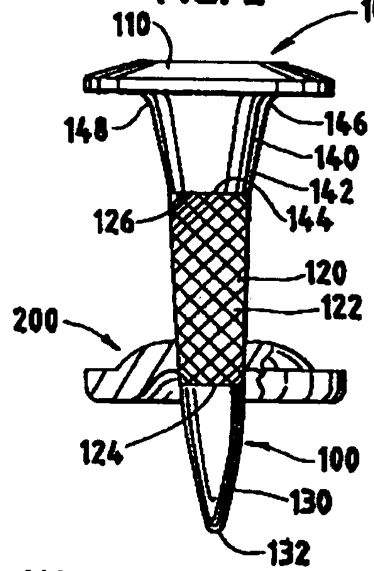


FIG. 3

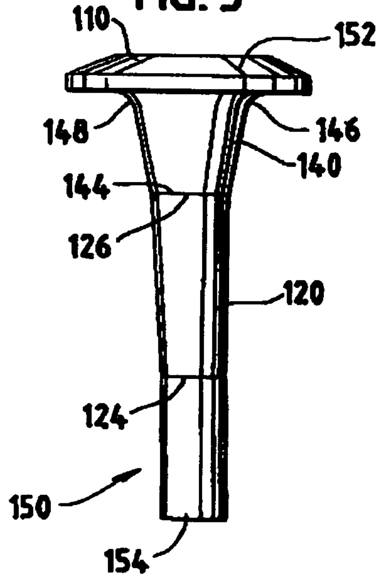


FIG. 4

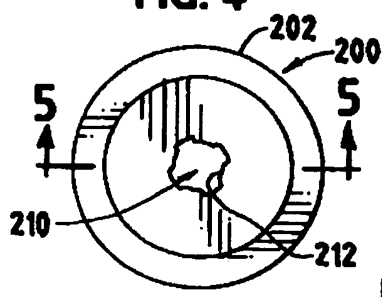


FIG. 5

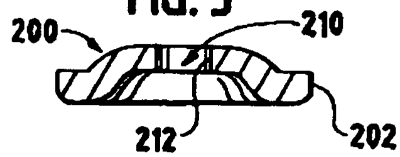


FIG. 6

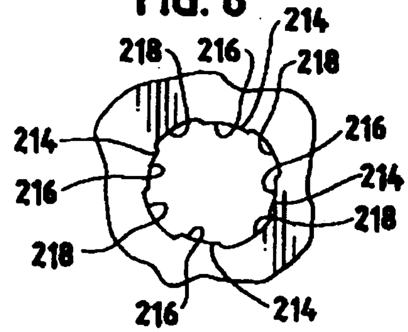


FIG. 7

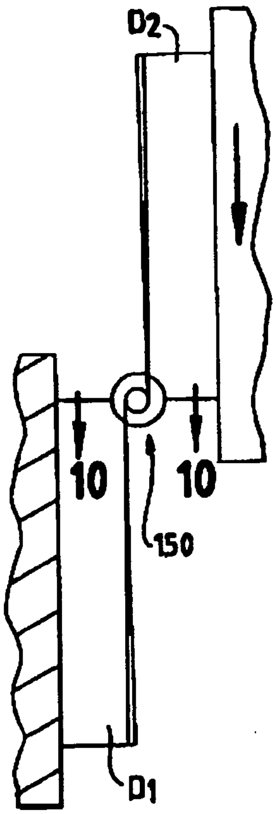


FIG. 8

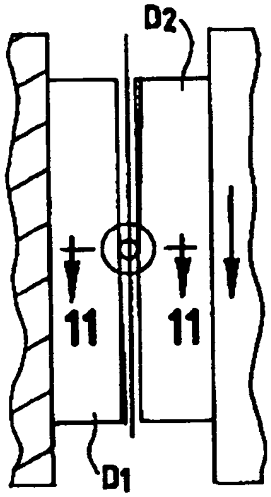


FIG. 9

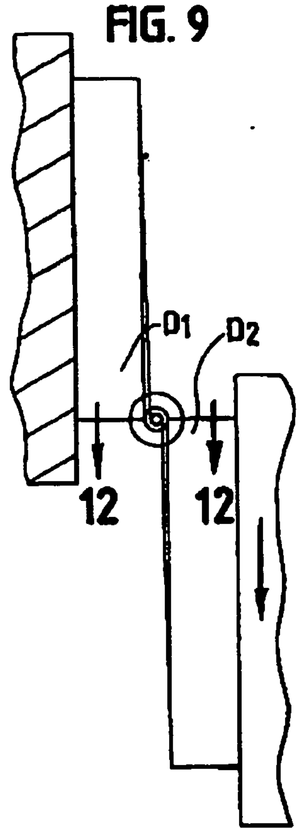


FIG. 10

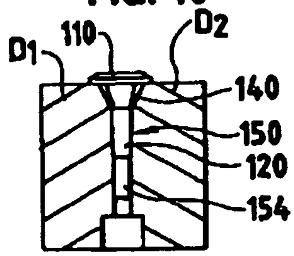


FIG. 11

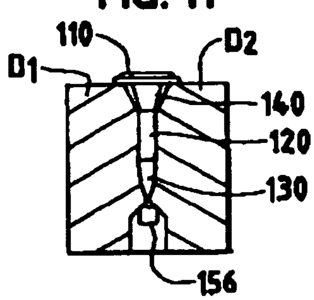
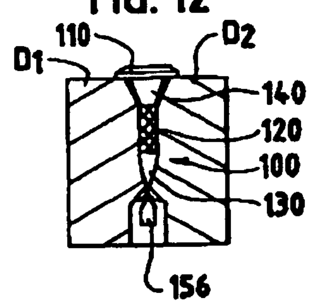


FIG. 12



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EUROPEAN SEARCH REPORT

Application Number
EP 98 40 3215

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26 March 1999	Calamida, G

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